Reading Education Report No. 62

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Abstract

Many students today are learning about computers. It is not clear, though, how computers should be used in school. This paper discusses the nature of the computer as a learning tool, and suggests ways in which computer based learning activities can fit into classrooms. In fact, the paper notes, the biggest impact of computers may be in terms of the ways they contribute to the social organization of the classroom.

Taking Control of Educational Technology

by Bertram Bruce

> There is no such thing as a neutral educational process. Education either functions as an instrument which is used to facilitate the integration of the younger generation into the logic of the present system and bring about conformity to it, or it becomes "the practice of freedom," the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world.
>
> Richard Shaull, 1970

One of the central debates in education is how to prepare students to meet the needs of a technologically-oriented society. A companion question concerns the ways technology should be used in teaching traditional subjects. These issues are usually discussed in terms of the efficiency of one teaching method versus another or in terms of how the limited time within the curriculum should be allocated. But prior to addressing these questions, we need to consider a more basic question about the role of computers in education: Will computers make education more of an instrument for bringing about conformity or can they assist "the practice of freedom?"

To address this question, this paper takes a practical approach, by considering what computers are and how they might be used most productively in education. The examples show, among other things, that the distinction between learning about computers and learning other subjects through the use of

computers is not that useful. More importantly, these examples are intended to suggest some ways to think about both progressive uses of computers in education and the creation of social and political environments in which such uses are more easily realized.

What Role Should Computers Play in Education?

Many people see computers as ideal for the present educational system, in that they can smooth some rough edges: they can protect against "cheating," they can ensure that children don't read materials they are not ready for, they can monitor student progress along pre-defined lines, limit the impact of the "teacher variable" (i.e., the power and importance of the individual teacher), and perhaps most importantly, they can reduce costs (assuming teachers can be replaced by machines).

The alliance of these considerations with the profit motive has resulted in a tremendous push for computers in schools. Last year, for example, major computer manufacturers, led by Apple Computer, sought substantial tax breaks in return for massive installation of computers in schools. Large school districts are now purchasing computers en masse. Boston, for instance, recently reached an agreement with IBM to purchase 800 computers for its schools (Boston Globe, 1984). Much of this momentum has occurred with little understanding of the eventual uses and consequences of computers in schools.

Parents' legitimate concerns about jobs for their children have also fueled the current computermania. Many parents believe

that if their children learn how to program they will automatically become eligible for high-paid, high-tech jobs, not realizing that most of the employment in the high-tech field is low-paid, non-union factory work.

In contrast, others, such as the Crabapple group, have taken decidedly negative positions about the current push for computers in schools. They argue that there are societal needs far more pressing than turning every classroom into a high-tech center. Moreover, they see the emphasis on computer programming as a misleading promise about jobs that will not be there. They also see computers as emphasizing piecemeal learning, rather than supporting more holistic, critical or creative education.

Finally, some feel that the use of computers in schools needs to be encouraged precisely because it does foster progressive education. For example, the International Council for Computers in Education (ICCE), an Oregon-based group that publishes The Computing Teacher, promotes the use of computers in education. While critical articles are published (the April 1984 issue, for example, focuses on equity), the general thrust is not to question but rather to encourage greater use of computers in schools. At various conferences on computers in education, many speakers go far beyond the ICCE in insisting on the value, even the need, for computers in schools. They lament the "resistance" that others in education still profess.

The problem with all of these views is that they tend to locate the source of the computer's power to effect education in the computer itself. Thus we hear that "Computers will teach children to read," or "Computers will turn schools into assembly lines." In fact, computers per se do nothing: they are simply tools which can amplify the power people have and the social relations they engage in. In that sense, the positive or the negative consequences realized by computers will be caused by people making use of computers to accomplish ends for change in education.

What Kind of Tool is a Computer?

Although we often associate computers with numbers and the repetitive calculations needed by banks, insurance companies, manufacturers, and so on, the essence of the digital computer lies not in adding columns of numbers but in its function as a tool for creating, manipulating and communicating symbols, in short, as a tool for language and thinking. Many teachers have begun to see this and to use the computer as a tool for expanding children's opportunities to solve problems (using programming languages such as Logo), to develop ideas (using "micro-world" simulation programs), to gain access to information (using computer networks and public data bases), to explore scientific questions (using statistics programs and computers connected to measuring devices, such as thermometers), to write and to share their writing (using text editors, publishing programs, and

networks). This view of computers as a symbol tool emphasizes the creation of contexts in which meaningful activities are encouraged and supported. Specific skills are then learned first in the contexts in which they are most appropriate.

The prevalent view of computers for the classroom, however, still seems to be one in which the computer "teaches" by controlling information and managing student efforts. Such uses limit rather than expand children's possibilities for learning. Within this restricted view, computers are seen as useful solely for teaching specific concepts or skills: punctuation, spelling, simple arithmetic calculations, state capitals, subject-verb agreement, etc., or for managing the process of instruction. If we are to go beyond this view we need to rethink some assumptions about how to use computers in the classroom.

One study found that teachers who had a chance to study computer software for use in the classroom argued for software that allowed the student to use the computer as a tool for learning rather than for software that put the computer in the dominant role, with the student pressing buttons on cue. The "teachers saw the enormous pedagogical differences between apparent user control and real user control, between answering questions and formulating them, between recognizing someone else's ideas and creating your own" (Olds, Schwartz, & Willie, 1980).

Why then do so many classrooms use the computer as a manager or a drill master? One reason, of course, is that much of the pressure to install computers in schools comes from a desire to automate the classroom, to make it more "efficient." This means, in the view of the computer's proponents, that the teacher's role must be diminished and circumscribed; new management controls need to be introduced. Thus, the computer becomes a device to channel student efforts, to measure and control what students do in school. A corrollary of this is that teachers are kept out of the decision-making that directly affects them and the students in their classrooms.

Some Ideas for Putting the Computer in its Place

The attempt to make computers into the shop foremen of the classroom has not been universally successful. But there is little support from the educational system or the available software, books, and articles to use computers in more creative and open-ended ways. By using the computer only in the most restricted ways we let the computer become the center of attention rather than the student. Below are some observations about how computers relate to education that might help teachers, parents, or learners redress this imbalance and put the computer in its place. One component of these observations is that choosing among specific software products is far less important than understanding categories of programs and their contexts of

use. As a result, endorsement of specific programs here has been avoided and only a few programs are named where necessary.

The computer's effect on learning. We often discuss computers in terms of their technological aspects-speed, memory size, functions, etc. and neglect to consider how they fit into a social context. Yet the biggest impact of computers in classrooms may be in terms of the ways they contribute to the social organization of a classroom rather than on how they "teach" specific concepts.

For example, it is often asserted that the use of word processors by children will help them become better writers. The argument is that since good writing depends on developing revision skills, a tool which makes revision easier will encourage children to practice revision more. This may well be true, but careful observations of classrooms where word processors are in use have revealed that other factors are also at work (Bruce, Michaels & Watson-Gegeo, in press).

In a classroom in Hartford, Connecticut, a great amount of revising did occur. But the reasons were not purely technological. Because the computer was a limited resource, students tended to "mill around" the computer waiting for their turn to use it. During that waiting period they would read what others had written and decide to modify their own early drafts. Also they tended to value highly what was written on the computer and felt it was worth the effort to revise. Both of these

factors--the opportunity to read others' writing and the value placed on computer writing--contributed to an increased amount of revision, which may, in the end, have helped the children become better writers. Understanding the process that was occurring in that classroom, a teacher might conclude that overall the computer had a positive impact on learning. But it would be important to remember that it was not the computer alone which brought about the changes, but rather the way the teacher and the students organized themselves for learning.

The major prerequisites for successful use of the computer are not characteristics of the software or hardware, per se, but of the classroom, the teacher, the principal, and the curriculum. Teachers who have a clear idea of what they want to have happen in the classroom can find software that facilitates it, but choosing software without thinking of educational goals and particular classroom needs first is likely to be ineffective at best.

Expert advice. The software evaluations published by various organizations, such as the Educational Products Information Exchange (EPIE), and the reviews in magazines such as Classroom Computer Learning and Electronic Learning provide useful information but should never be taken as the sole guide for selecting software. The problem is not just that the expert may have a different educational philosophy and sensibility about computers. Nor is it just that every expert has a limited sample

of the thousands of programs currently available. The core problem is that evaluations of software do not begin to take into account all the ways that software might be used. The recommendations of experts can be useful for assessing a program's potential as well as its limitations, but the real worth of a program is determined by how it is used in a particular classroom.

The floppy disk cover. Programs are not always successful at teaching what the disk cover claims, and some of those that are successful tend to focus on rapid performance of skills out of context without helping children in any significant way to become better problem solvers or users of language. A basic problem is that most software is produced to meet profit goals first, and educational goals second, if at all. Most software designers are not educators and may have poor intuition about how children learn. Educators who design software may likewise do a poor job if they are not familiar with what a computer can do. Thus, what appears from the cover to be a useful program for teaching may be of no use at all.

On the other hand, some programs not presented as "educational" may be ideal for teaching. For example, general communications tools (often catalogued as "administrative aids"), such as data base programs, text editors, and electronic mail can give students the chance to use language in expanded ways for real communication. Programs that plot data or help in

constructing tables may be useful in learning scientific methods even though they are not stricly defined as educational. And, general purpose programming languages can be used for purposes other than developing "computer literacy." For example, a language such as "Logo" (Feurzeig, Papert, Bloom, Grant, & Solomon, 1969) can be used to study language structures or mathematical relationships (as well as to draw pictures, its major claim to fame).

Finally, a program that appears to be useful for one educational task may have unsuspected uses. There is a text editor now being marketed which comes with a speech synthesizer that can say each letter or word as it is typed (Rosegrant & Cooper, 1983). The justification for the program is that it helps young children learn to read and write. But a teacher of older students might find that such a program would be useful in teaching the concept of symbol-to-sound rules. This could be valuable in learning a foreign language or might be a useful adjunct to teaching general linguistics.

Creating computer learning activities. Teachers who are not programmers can nevertheless create their own computer learning activities in a variety of ways. They may, as suggested above, find new ways to use existing software, especially the more open-ended variety. But equally important, teachers can use general purpose software, such as word processing programs, to mimic many of the packaged programs being marketed. For example, one new

program is a game in which one student inserts a sentence into a pre-existing text and a second student tries to guess the added or "suspect" sentence. This game helps students become more sensitive to such things as textual coherence and author's style.

A teacher--or better yet, a group of students--could devise a procedure for using a text editor which retains the significant aspects of this language game. (It is relatively easy with most text editors to insert a sentence and reformat the paragraph so that it is not obvious that a sentence has been added.) Having the students select texts to use and devise scoring procedures can be as educationally beneficial as playing the game itself.

Recommended uses. Experiences with "Quill" (Rubin, Bruce, and the Quill Project, 1984) a program for teaching composition, reveal in a direct way how decisions about the use of computers in schools must be informed by the needs of students and teachers. For example, a group I helped to lead designed a part of Quill to assist the planning aspects of writing. We saw it as a tool to help in organizing a first draft of a piece of writing. Although it has been successfully used in that way, we've found that some teachers have used the same program more productively in ways we only dimly anticipated.

One teacher had students use it as a tool to create interview forms. The students used these forms in doing community studies--interviews with elderly residents about food, clothing and housing needs. (They could use the computer to

revise the forms easily as needed.) Another teacher used the program to create a tool for doing science lab reports. Students then used the computer to record data (from a table-top greenhouse project) using diagrams in their science textbooks to help analyze what was happening. The computer became a tool for facilitating the connection between their real world observations of plant growth and the abstractions of their books. These uses of the computer were successful because they grew out of real classroom needs and were not restricted to the suggestions for use given in the teacher's guide. If we had assumed that our vision alone was sufficient, we might have stifled creative, classroom appropriate uses of the computer.

Students can also use programming languages to create their own learning activities such as science simulations, bulletin boards, adventure games (Sopp, 1984), and so on. This last approach has the added value of narrowing the artificial gap now established between learning about computers and learning other subjects through the use of computers.

The computer is a powerful educational tool. It can be used to limit children's access to information, to control the way they read and write, and to restrict their modes of learning, or it can allow children to communicate easily with others and to access information in a way that greatly expands their world. If computers are to be worthwhile tools, we must never let computer

needs or faulty educational ideas embodied in computer programs come before the needs of children.

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Abstract

The issue that this paper focusses on is whether the use of computers in education will mitigate, maintain, or even increase existing inequalities. Boys, and students in wealthier school districts, for example, have more opportunities to work with computers. There may also be SES related differences in the kinds of instruction that students receive through computers. The paper argues that issues of fairness and general educational value should take precedence over existing social stereotypes and political barriers. Teacher policies and practices are discussed in terms of their relationship to equality of access and opportunity.

Whose Computer is it Anyway?

There are now approximately 300,000 microcomputers in schools in the U.S. with most school districts scrambling to purchase more. The intensity of this interest in school computers is at least in part attributable to parental concerns about future job prospects for their children. Computer hardware and software makers have tended to reinforce such commonly held, but little substantiated, beliefs about children and computers. Nevertheless the growing evidence is that the high-tech society has a greater need for low paid, semi-skilled factory workers than for high paid systems analysts.

There are questionable assumptions being made about why computers should be in schools, but it is true that there may well be considerable benefits to having them there. Computers can in principle be used to make educational resources more equitably distributed (e.g., through network access to data bases and library resources), to facilitate more active student involvement in and control of learning (e.g., through the use of computer tools such as text editors and programming languages), and partially to address the needs of students who are victims of educational neglect.

Unfortunately, the progressive potential of the computer is all too often unrealized. As is so often the case with new technologies, computer use is more apt to reinforce existing

patterns than to change them. In many ways the introduction of computers appears to maintain or even increase existing inequalities in education, inequalities which predated the availability of computers.

While these inequalities were not caused by computers, they may well be reproduced and even accentuated by their use. We examine here three areas in which these problems arise: hardware, software, and classroom use. We present more examples on the third area because it is more apt to be overlooked in discussions of equity in computer use, and because the process by which inequalities are produced is more subtle.

Inequalities of Access

"There is a persistent and substantial inequality in the access to new technologies among both schools and school children." So said Tarr-Whelan, the President of the National Education Association, before the House Subcommittee on Science, Research and Technology this spring. The inequality is in computer/student ratios among categories of schools. Not surprisingly, urban schools with a high proportion of poverty-level families have fewer computers than either suburban or rural schools.

One of the bills on computer education now before Congress--the Computer Education Assistance Act introduced by Senator Frank Lautenberg--reserves 50% of the Federal funds for hardware purchases by poverty area school districts. But even if that

bill should become law, which seems unlikely, it will only alleviate inequality at one level of the education system, and there are other ways in which computers aggravate existing inequalities rather than reduce them.

Inequalities of Software Usage

Even if urban schools should catch up in the number of computers owned and if access of some kind of computer should become equalized from school to school, there may still be substantial educational inequality. The number of computers in a school is a poor indicator of the quality of the educational experiences that students get when they sit down at the terminal. Here, too, inequalities are already apparent:

"While middle class students, especially those who are in advanced programs (e.g., Gifted and Talented Education) receive instruction which encourages learner initiative (programming and problem solving), low income and ethnic minority students receive instruction which maintains the control of learning within the program (computer aided drill and practice)" (Boruta, Carpenter, Harvey, Keyser, LaBonte, Mehan & Rodriquez, 1983).

For example, Rand Corporation researchers conducted an intensive study of 40 elementary and 20 secondary teachers in California who were nominated as exemplary computer users in mathematics and science instruction (Shavelson, Winkler, Stasz, Feibel, Robyn & Shaha, 1984). Four patterns of computer use emerged from their analyses: orchestration--with the widest

variety of uses directly linked to the regular curriculum; enrichment--which familiarized students with computers as a separate subject; adjunct instruction--that selectively augmented math and science lessons; and drill and practice in basic skills. On the question of equity, they conclude:

> classrooms with students above average in ability and low in numbers of minorities tended to be found with teachers characterized as "orchestrating" . . .
>
> [Whereas] the five classrooms with a high percentage of minority students low in ability employed computers to deliver drill and practice. (p. 62)

No one claims that computers have created this disparity in educational experiences, but they certainly appear to reinforce it.

Some studies have found greater access to and use of computers by boys than by girls, especially at the high school level and during electives and after-school periods.

> Boys outnumber girls 2 to 1 in high school programming courses and 3 to 1 in attendance at computer camps. Girls have less access to computers at home and are less likely to participate in free time (out of class) computer use at school. (Russell, Mokros & Foster, 1984)

But here, the type of computer software and computer use makes a difference. Studies of computers used for writing by upper elementary school children have not found girls to be at a

disadvantage. In our own study of computers with writing software in two urban sixth grade classrooms (Microcomputers & Literacy) we found that girls were as likely to be star computer users as boys. And while some boys in each class were prolific writers on the computer, the girls overall did more computer writing than the boys. Moreover, when students were ranked by amount of computer writing done, and relative ranks were compared across time, girls in both classrooms tended to move up in rank over time while boys tended to move down.

The fact that computers seem to reinforce rather than change existing patterns still appears. If pre-computer sterotypes of male mathematicians vs. female writers exist, those patterns (orchestration for the rich/drill for the poor; greater access for boys; sterotypical use, etc.) are not necessary in any absolute sense. They occur because existing social and political relationships take precedence over issues of fairness or general educational value. The patterns of inequity persist unless they are deliberately and systematically countered.

Inequalities Within a Classroom

We know from studies of student-teacher interaction that students within any single classroom receive differential treatment from the teacher. Considered positively, this differential treatment is called "individual instruction." Considered negatively, it is a source of discrimination and self-fulfilling prophecies. Computers are very different from

teachers in one way, and like them in another. The difference--often mentioned by advocates of computer instruction for minority children--is that computers don't see the color of children's skin or hear their non-standard speech. Teachers form expectations on the basis of unconscious reactions to cues such as these; computers do not. That is an important difference.

But the similarity is that a computer, like a teacher, is a scarce resource, and in the allocation of this resource within a single classroom, the gap between the haves and the have-nots can be widened. In our observations of two urban sixth grade classrooms, each with a computer used for writing, we have seen teachers integrate the computer very differently into their writing programs. These observations have led us to raise some general questions about the relationship between computer use within a classroom and students' access to computer time and expertise.

If the computer is used in the final stage of writing to produce a neat, typewritten copy (rather than as a text-editing tool), the speed with which a student writes a first, hand-written draft often determines his or her number in line to enter text on the computer. Students who start out writing better and quicker often are rewarded by a prompt turn, which allows for a prompt (and probably more meaningful) connection between what they wrote on paper and what they entered into the computer.

If access to the computer is strictly controlled by the teacher (so that students have scheduled times or have to have their writing checked and OK'ed by the teacher before writing on the computer), then absenteeism is likely to influence how much time a student has on the computer. Students who are absent often (for whatever reason) are more likely to miss their turn or be denied their turn while making up other assignments. This is often the case with students who are pulled out of the classroom for special tutoring (such as students with diagnosed learning disabilities or Title I status). Thus students who have the most to gain from time on the computer are often kept off because of institutionalized absenteeism (known as "pull-out" programs). Alternatively, some teachers have found that by making use of innovative approaches such as peer tutoring, students do not necessarily fall behind just because they miss a lesson.

Another kind of access to the computer comes through students' knowledge of text-editing commands used for inserting, deleting, and rearranging text. Different teachers have different strategies for teaching their students text-editing skills. If a teacher becomes fully versed in the commands, group and individualized instruction are possible, so that the entire class can be given basic information, and advanced instruction can be provided to those students who seem "ready" for it. If a teacher does not become proficient with the commands, access to necessary skills becomes more problematic for many students.

As an example, one of the teachers in our study did not fully master the text-editing commands. Instead, she selected one student--a boy who seemed interested in and facile with the computer--to become the classroom "expert." She had another teacher (who was herself an expert) give the student individual instruction, and then directed the other students to consult him with questions about computer commands. By the end of the school year, only this student had mastered all the basic text-editing commands and fully understood the mode orientation of the text editor. Two other students, both of whom were close friends of the student-expert, knew a few commands.

In this classroom, voluntary grouping at the computer was allowed when students had free time. As a rule, groupings at the computer divided along sex lines (as did groupings in the lunchroom and on the playground). Not surprisingly, the student-expert's knowledge of text-editing commands diffused narrowly in this classroom and did not cross sex lines. Not a single girl in the class knew how to insert or delete text.

Thus how information about the computer is made available to students (via wall charts, formal instruction by the teacher, or informal teaching by a student expert) and how information is passed from student to student (through voluntary grouping or assigned pair work) limits or enlarges students' command over the technology.

Conclusion

Many children are effectively denied access to new educational technologies because they live in the wrong school district. Others are able to use computers, but only in the most limited ways. Our classroom study suggests that in addition to these inequalities in educational access, the same computer with the same software may be used very differently by different teachers, even in the same school and with the same student population. For this reason, if we are concerned about equity of computer distribution and use, we must have ways to evaluate the actual usage in real classrooms. Before asking what impact a computer with a particular kind of software will have on student learning, and whether it is good or not, we must ask what impact the classroom (and in particular, the teacher) will have on the way the computer is used. How will students get a turn? How is computer related information made available to students? These classroom specific factors, overlaid on system-wide factors such as computer and software availability, ultimately determine a student's access (or lack of access) to computer related learning opportunities.

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